HW: Problem 1

Determine a state variable representation for the following transfer functions using the ss function;

$$(a)\ G(s) = \frac{1}{s+25}$$

$$(b)\ G(s) = \frac{3s^2+10s+3}{s^2+8s+5}$$

$$(c)\ G(s) = \frac{s+10}{s^3+3s^2+3s+1}$$

HW: Problem 2

Determine a transfer function representation for the following state variable models using the tf function:

$$(a)\ A=\begin{bmatrix}0 & 1\\ 2 & 4\end{bmatrix};\ B=\begin{bmatrix}0\\ 1\end{bmatrix};C=[1\ 0]$$

$$(b)\ A=\begin{bmatrix}1 & 1 & 0\\ -2 & 0 & 4\\ 6 & 2 & 10\end{bmatrix};B=\begin{bmatrix}-1\\ 0\\ 1\end{bmatrix};C=[0\ 1\ 0]$$

$$(c)\ A=\begin{bmatrix}0 & 1\\ -1 & -2\end{bmatrix};\ B=\begin{bmatrix}0\\ 1\end{bmatrix};C=[-2\ 1]$$

HW: Problem 3

For the simple pendulum shown in Figure CP2.7, the nonlinear equation of motion is given by

$$\ddot{\theta}(t) + \frac{g}{L}\sin\theta = 0,$$

where $L = 0.5$ m, $m = 1$ kg, and $g = 9.8$ m/s^2. When the nonlinear equation is linearized about the equilibrium point $\theta = 0$, we obtain the linear time-invariant model,

$$\ddot{\theta} + \frac{g}{L}\theta = 0.$$

Create an m-file to plot both the nonlinear and the linear response of the simple pendulum when the initial angle of the pendulum is $\theta(0) = 30°$ and explain any differences.

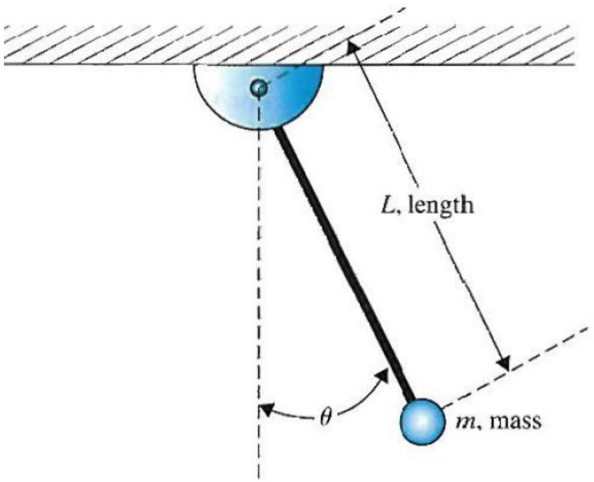

FIGURE CP2.7
Simple pendulum.

HW: Problem 4

A system has a transfer function

$$\frac{X(s)}{R(s)} = \frac{(15/z)(s + z)}{s^2 + 3s + 15}.$$

Plot the response of the system when $R(s)$ is a unit step for the parameter $z = 3, 6,$ and 12.

HW: Problem 5

Consider the circuit shown in Figure CP3.3. Determine the transfer function $V_0(s)/V_{in}(s)$. Assume an ideal op-amp.

(a) Determine the state variable representation when $R_1 = 1\,\text{k}\Omega$, $R_2 = 10\,\text{k}\Omega$, $C_1 = 0.5\,\text{mF}$, and $C_2 = 0.1\,\text{mF}$.

(b) Using the state variable representation from part (a), plot the unit step response with the step function.

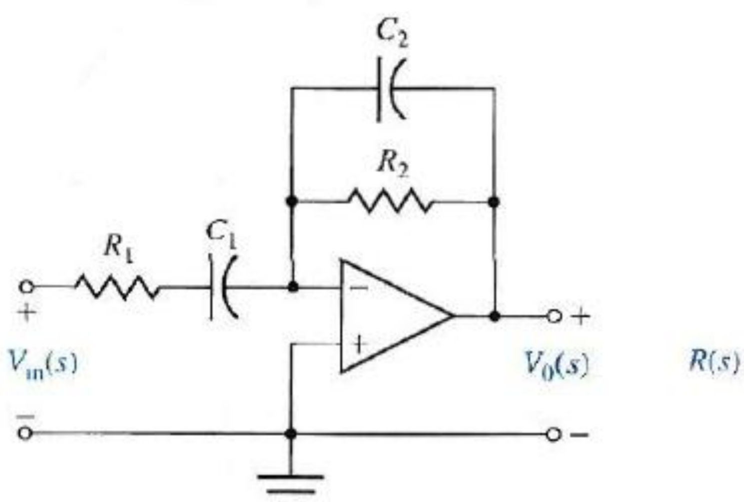

FIGURE CP3.3 An op-amp circuit.

HW: Problem 6

Consider the system

$$\dot{\mathbf{x}} = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ -3 & -2 & -5 \end{bmatrix} \mathbf{x} + \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix} u,$$

$$y = [1 \quad 0 \quad 0]\mathbf{x}.$$

(a) Using the tf function, determine the transfer function $Y(s)/U(s)$.

(b) Plot the response of the system to the initial condition $\mathbf{x}(0) = [0 \quad -1 \quad 1]^T$ for $0 \le t \le 10$.

HW: Problem 7

Using MATLAB function **ode23** obtain the numerical solution for the differential equation given by

$$\frac{d^2\theta}{dt^2} + \frac{B}{m}\frac{d\theta}{dt} + \frac{g}{l}\sin\theta = 0$$

Where $m = 0.5$ Kg, $l = 0.613$ m, $B = 0.05$ Kg-s/m, and $g = 9.81$ m/s^2.

The initial angle at time $t = 0$ is $\theta(0) = 0.5$ and $\dot{\theta}(0) = 0$.

HW: Problem 8

P2.27 Magnetic levitation trains provide a high-speed, very low friction alternative to steel wheels on steel rails. The train floats on an air gap as shown in Figure P2.27 [27]. The levitation force F_L is controlled by the coil current i in the levitation coils and may be approximated by

$$F_L = k\frac{i^2}{z^2},$$

where z is the air gap. This force is opposed by the downward force $F = mg$. Determine the linearized relationship between the air gap z and the controlling current near the equilibrium condition.

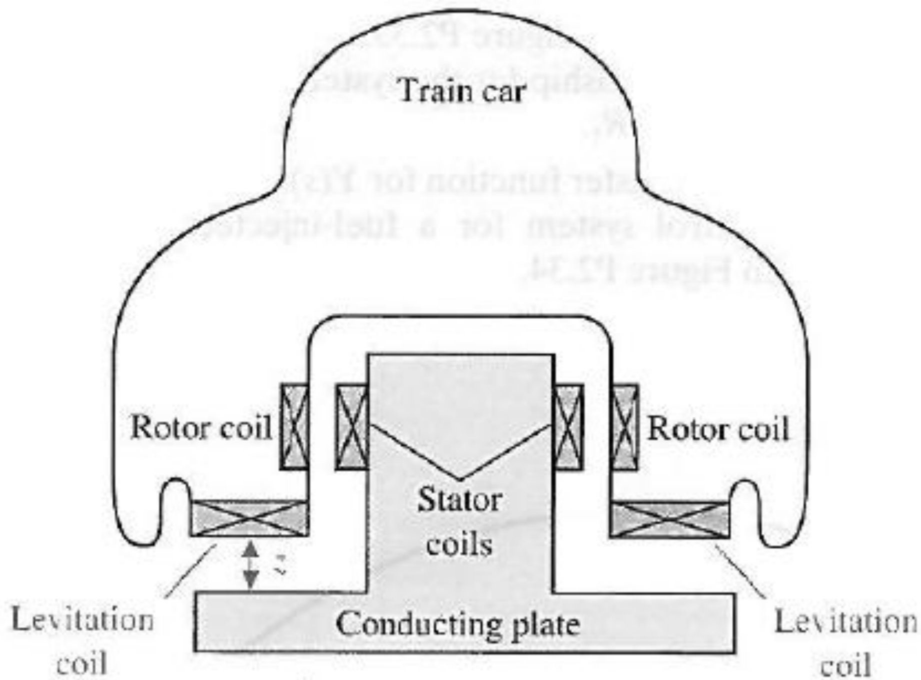

FIGURE P2.27 Cutaway view of train.